

**WHAT IS CLAIMED IS:**

1. A method of obtaining a digital code representative of a skin-covered body part, the method including:
  - acquiring an image of the skin-covered body part, the image including a plurality of pixels, each pixel having an associated shade value in a range of shade values;
  - identifying a plurality of subsets of pixels from the plurality of pixels, each subset of pixels including at least two pixels having a common one of a plurality of designated shade values in the range of shade values;
  - for each of a plurality of combinations of pixels taken from the pixels in the subsets of pixels, determining a geometric measure of the pixels in said combination;
  - encoding the geometric measures into a digital code for the skin-covered body part.
2. The method defined in claim 1, wherein said acquiring an image of the skin-covered body part is performed by a CMOS charge-coupled device.
3. The method defined in claim 1, wherein the image is derived from a live scan of the skin-covered body part pressed onto a platen.
4. The method defined in claim 1, wherein said identifying a plurality of subsets of pixels from the plurality of pixels includes identifying a first subset of pixels and identifying a second subset of pixels.
5. The method defined in claim 4, wherein said identifying a first subset of pixels includes:
  - identifying a first pixel having any of the designated shade values;
  - identifying a second pixel having the same designated shade value as the first pixel;wherein the first subset of pixels includes said first and second pixels.

- 1 6. The method defined in claim 5, wherein said identifying a second subset of pixels  
2 includes:
  - 3 - identifying a third pixel having any of the designated shade values;
  - 4 - identifying a fourth pixel having the same designated shade value as the third  
5 pixel;- 6 wherein the second subset of pixels includes said third and fourth pixels.  
7
- 8 7. The method defined in claim 6, wherein identifying the first pixel includes  
9 identifying which pixel having the designated shade value is nearest a reference  
10 point in the image.  
11
- 12 8. The method defined in claim 7, wherein identifying the second pixel includes  
13 identifying which pixel having the designated shade value is nearest the first pixel.  
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- 15 9. The method defined in claim 7, wherein identifying the second pixel includes  
16 identifying which pixel separated from the first pixel by at least a minimum  
17 distance and having the designated shade value is nearest the first pixel.  
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- 19 10. The method defined in claim 7, wherein identifying the second pixel includes  
20 identifying which pixel having the designated shade value is second nearest the  
21 reference point.  
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- 23 11. The method defined in claim 7, wherein identifying the second pixel includes  
24 identifying which pixel separated from the first pixel by at least a minimum  
25 distance and having the designated shade value is second nearest the reference  
26 point.  
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- 28 12. The method defined in claim 11, wherein the reference point is a center of the  
29 image.  
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- 31 13. The method defined in claim 11, wherein the reference point is a corner of the  
32 image.  
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- 1 14. The method defined in claim 11, wherein the reference point is a salient feature of  
2 the image.  
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- 4 15. The method defined in claim 14, further including identifying the salient feature of  
5 the image.  
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- 7 16. The method defined in claim 1, further including consulting a database to obtain  
8 the designated shade values.  
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- 10 17. The method defined in claim 1, wherein the plurality of designated shade values  
11 are pre-determined and independent of the image.  
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- 13 18. The method defined in claim 1, further including selecting the plurality of  
14 designated shade values on a basis of a characteristic of the image.  
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- 16 19. The method defined in claim 1, wherein the designated shade values are grayscale  
17 values.  
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- 19 20. The method defined in claim 1, wherein the range of shade values includes 256  
20 grayscale values.  
21
- 22 21. The method defined in claim 1, wherein each said combination of pixels includes  
23 a respective first pixel and a respective second pixel, and wherein determining a  
24 geometric measure of the pixels in a particular one of the plurality of  
25 combinations includes determining a distance between the respective first pixel  
26 and the respective second pixel.  
27
- 28 22. The method defined in claim 21, wherein said determining a distance between the  
29 respective first pixel and the respective second pixel includes determining a  
30 number of pixels separating the respective first pixel and the respective second  
31 pixel.  
32
- 33 23. The method defined in claim 21, wherein said determining a distance between the  
34 respective first pixel and the respective second pixel includes determining a first

1        number of pixels separating the respective first pixel and the respective second  
2        pixel along a first direction and determining a second number of pixels separating  
3        the respective first pixel and the respective second pixel along a second direction  
4        orthogonal to the first direction.

5  
6        24. The method defined in claim 1, wherein each said combination of pixels includes  
7        at least three respective pixels.

8  
9        25. The method defined in claim 24, wherein determining a geometric measure of the  
10       pixels in a particular one of the plurality of combinations includes determining an  
11       average distance among all pairs of the at least three respective pixels.

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13       26. The method defined in claim 24, wherein determining a geometric measure of the  
14       pixels in a particular one of the plurality of combinations includes determining an  
15       area of a polygon constructed from the at least three respective pixels.

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17       27. The method defined in claim 24, wherein determining a geometric measure of the  
18       pixels in a particular one of the plurality of combinations includes determining an  
19       average distance to a center of mass of the at least three respective pixels.

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21       28. The method defined in claim 1, wherein each combination of pixels includes a  
22       plurality of pixels taken from the same subset of pixels.

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24       29. The method defined in claim 1, wherein all the pixels in a particular one of the  
25       combinations of pixels are taken from the same subset of pixels.

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27       30. The method defined in claim 1, wherein each combination of pixels includes at  
28       least two pixels taken from different subsets of pixels.

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30       31. The method defined in claim 1, wherein said encoding the geometric measures  
31       into a digital code includes concatenating the geometric measures into the digital  
32       code.

1 32. The method defined in claim 1, further including encoding the designated shade  
2 values into the digital code.

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4 33. The method defined in claim 1, further including encrypting the digital code.

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6 34. The method defined in claim 1, wherein the skin-covered body part includes a  
7 finger tip.

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9 35. The method defined in claim 1, wherein the skin-covered body part does not  
10 include a finger tip.

11  
12 36. The method defined in claim 1, wherein the skin-covered body part includes a  
13 nose tip.

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15 37. The method defined in claim 1, wherein the skin-covered body part includes a  
16 palm of a hand.

17  
18 38. The method defined in claim 1, wherein the skin-covered body part includes an  
19 ear.

20  
21 39. A computer-readable storage medium containing a program element for execution  
22 by a computing device to implement a method of obtaining a digital code  
23 representative of a skin-covered body part, the program element including:

- 24 - program code means for acquiring an image of the skin-covered body part, the  
25 image including a plurality of pixels, each pixel having an associated shade  
26 value in a range of shade values;
- 27 - program code means for identifying a plurality of subsets of pixels from the  
28 plurality of pixels, each subset of pixels including at least two pixels having a  
29 common one of a plurality of designated shade values in the range of shade  
30 values;
- 31 - program code means for determining, for each of a plurality of combinations  
32 of pixels taken from the pixels in the subsets of pixels, a geometric measure of  
33 the pixels in said combination;

- 1       - program code means for encoding the geometric measures into a digital code
- 2       for the skin-covered body part.

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4   40. An apparatus for obtaining a digital code representative of a skin-covered body

5       part, the apparatus including:

- 6       - means for acquiring an image of the skin-covered body part, the image
- 7       including a plurality of pixels, each pixel having an associated shade value in a
- 8       range of shade values;
- 9       - means for identifying a plurality of subsets of pixels from the plurality of
- 10       pixels, each subset of pixels including at least two pixels having a common
- 11       one of a plurality of designated shade values in the range of shade values;
- 12       - means for determining, for each of a plurality of combinations of pixels taken
- 13       from the pixels in the subsets of pixels, a geometric measure of the pixels in
- 14       said combination;
- 15       - means for encoding the geometric measures into a digital code for the skin-
- 16       covered body part.

17

18   41. An apparatus operative to control a state of an access point, including:

- 19       - a biometric module adapted to acquire an image of a skin-covered body part
- 20       submitted thereto;
- 21       - a processing module adapted for:
  - 22           - responsive to acquisition of an image by the biometric module, producing
  - 23           a candidate code based on geometric measures of respective combinations
  - 24           of pixels taken from a plurality of subsets of like-shaded pixels in the
  - 25           image;
  - 26           - causing a comparison to be performed between the candidate code and a
  - 27           set of references codes;
  - 28           - responsive to receipt of a signal indicative of the comparison yielding a
  - 29           match between the candidate code and one of the reference codes, sending
  - 30           a release signal to a restraint mechanism to cause the restraint mechanism
  - 31           to release the access point.

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1 42. The apparatus defined in claim 41, wherein said producing a candidate code based  
2 on geometric measures of respective combinations of pixels taken from a plurality  
3 of subsets of like-shaded pixels in the image includes:

- 4 - identifying a plurality of subsets of pixels from the plurality of pixels, each  
5 subset of pixels including at least two pixels having a common one of a  
6 plurality of designated shade values;
- 7 - for each of a plurality of combinations of pixels taken from the pixels in the  
8 subsets of pixels, determining a geometric measure of the pixels in said  
9 combination;
- 10 - encoding the geometric measures into said candidate code.

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12 43. The apparatus defined in claim 41, wherein the access point is one of a door, a  
13 turnstile, a window, a vault, a revolving door, an elevator and a gate.

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15 44. The apparatus defined in claim 41, further including a memory for storing the set  
16 of reference codes.

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18 45. The apparatus defined in claim 44, wherein said causing a comparison to be  
19 performed between the candidate code and a set of reference codes includes  
20 effecting a comparison between the candidate code and the set of reference codes  
21 stored in the memory.

22  
23 46. The apparatus defined in claim 45, wherein the processing module is further  
24 adapted for receiving the set of reference codes from an external device.

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26 47. (A) The apparatus defined in claim 41, further including a communication  
27 interface.

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29 48. The apparatus defined in claim 47, wherein said causing a comparison to be  
30 performed between the candidate code and a set of reference codes includes  
31 sending the candidate code to a management entity via the communication  
32 interface for comparison at the management entity of the candidate code with the  
33 set of reference codes.

1 49. The apparatus defined in claim 48, wherein said sending the candidate code is  
2 performed at least partly over a wireless link.

3  
4 50. The apparatus defined in claim 48, wherein said sending the candidate code is  
5 performed at least partly over a wired link.

6  
7 51. The apparatus defined in claim 41, wherein the processing module is further  
8 adapted for:

- 9 - responsive to receipt of a signal indicative of the comparison yielding no  
10 match between the candidate code and any of the reference codes,  
11 generating an alarm signal.

12  
13 52. The apparatus defined in claim 47, wherein the processing module is further  
14 adapted for:

- 15 - responsive to receipt of a signal indicative of the comparison yielding no  
16 match between the candidate code and any of the reference codes,  
17 generating an alarm signal and sending the alarm signal via the  
18 communication interface towards a destination.

19  
20 53. The apparatus defined in claim 52, wherein the alarm signal is sent at least partly  
21 over a wireless link.

22  
23 54. The apparatus defined in claim 52, wherein the alarm signal is sent at least partly  
24 over a wired link.

25  
26 55. The apparatus defined in claim 52, wherein the destination is a security agent or a  
27 security desk.

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29 56. The apparatus defined in claim 41, wherein the biometric module includes a platen  
30 designed to receive the skin-covered body part.

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32 57. The apparatus defined in claim 56, wherein the skin-covered body part includes a  
33 finger tip.



1 58. The apparatus defined in claim 56, wherein the skin-covered body part does not  
2 includes a finger tip.

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4 59. The apparatus defined in claim 56, wherein the skin-covered body part includes a  
5 nose tip.

6  
7 60. The apparatus defined in claim 56, wherein the skin-covered body part includes a  
8 palm of a hand.

9  
10 61. The apparatus defined in claim 56, wherein the skin-covered body part includes an  
11 ear.

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13 62. The apparatus defined in claim 41, further including a communication interface  
14 connected to a management entity by a cable.

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16 63. The apparatus defined in claim 62, wherein the cable supplies electrical power to  
17 the apparatus.

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19 64. The apparatus defined in claim 63, wherein the cable is an Ethernet cable.

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21 65. The apparatus defined in claim 47, wherein sending the release signal is  
22 performed via the communication interface.

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24 66. The apparatus defined in claim 65, wherein the release signal reaches the restraint  
25 mechanism at least partly over a wireless link.

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27 67. The apparatus defined in claim 65, wherein the release signal reaches the restraint  
28 mechanism at least partly over a wired link.

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30 68. The apparatus defined in claim 41, incorporated into a door.

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32 69. The apparatus defined in claim 41, further including the restraint mechanism.

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34 70. The apparatus defined in claim 69, incorporated into a door.

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71. A method of controlling a state of an access point, including:
- responsive to acquisition of an image of a skin-covered body part submitted to a biometric module, producing a candidate code based on geometric measures of respective combinations of pixels taken from a plurality of subsets of like-shaded pixels in the image;
  - causing a comparison to be performed between the candidate code and a set of references codes;
  - responsive to receipt of a signal indicative of the comparison yielding a match between the candidate code and one of the reference codes, sending a release signal to a restraint mechanism to cause the restraint mechanism to release the access point.
72. An apparatus for controlling a state of an access point, including:
- means responsive to acquisition of an image of a skin-covered body part submitted to a biometric module, for producing a candidate code based on geometric measures of respective combinations of pixels taken from a plurality of subsets of like-shaded pixels in the image;
  - means for causing a comparison to be performed between the candidate code and a set of references codes;
  - means responsive to receipt of a signal indicative of the comparison yielding a match between the candidate code and one of the reference codes, for sending a release signal to a restraint mechanism to cause the restraint mechanism to release the access point.
73. An apparatus including:
- a communication interface capable of communication with a management entity over a network;
  - a biometric module adapted to acquire an image of a skin-covered body part submitted thereto;
  - an output device;
  - a processing module adapted for:

- 1           - releasing a prompting signal via the output device, the prompting signal
- 2           prompting submission of a skin-covered body part at the biometric
- 3           module;
- 4           - responsive to acquisition of an image by the biometric module further to
- 5           releasing the prompting signal, producing a candidate code based on
- 6           geometric measures of respective combinations of pixels taken from a
- 7           plurality of subsets of like-shaded pixels in the image;
- 8           - releasing the candidate code via the communication interface for
- 9           comparison at the management entity with an expected code, thereby to
- 10          verify presence of a person associated with the expected code.

11

12   74. The apparatus defined in claim 73, wherein said producing a candidate code based

13       on geometric measures of respective combinations of pixels taken from a plurality

14       of subsets of like-shaded pixels in the image includes:

- 15       - identifying a plurality of subsets of pixels from the plurality of pixels, each
- 16       subset of pixels including at least two pixels having a common one of a
- 17       plurality of designated shade values;
- 18       - for each of a plurality of combinations of pixels taken from the pixels in the
- 19       subsets of pixels, determining a geometric measure of the pixels in said
- 20       combination;
- 21       - encoding the geometric measures into said candidate code.

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23   75. The apparatus defined in claim 73, wherein the processing module is further

24       adapted for receiving a presence verification signal from the management entity.

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26   76. The apparatus defined in claim 75, wherein said releasing a prompting signal is

27       performed in response to receipt of the presence verification signal.

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29   77. The apparatus defined in claim 76, wherein the network is the public switched

30       telephone network.

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32   78. The apparatus defined in claim 77, wherein the communication interface includes

33       a modem.

1 79. The apparatus defined in claim 73, wherein the processing module is further  
2 adapted for generating a presence verification signal.

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4 80. The apparatus defined in claim 79, wherein said releasing a prompting signal is  
5 performed in response to generation of the presence verification signal.

6  
7 81. The apparatus defined in claim 80, further including a memory for storing time  
8 instants, and wherein the processor is further adapted for generating the presence  
9 verification signal at the time instants stored in the memory.

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11 82. The apparatus defined in claim 73, wherein the output device is a loudspeaker.

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13 83. The apparatus defined in claim 73, wherein the biometric module includes a platen  
14 designed to receive the skin-covered body part.

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16 84. The apparatus defined in claim 83, wherein the skin-covered body part includes a  
17 finger tip.

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19 85. The apparatus defined in claim 83, wherein the skin-covered body part does not  
20 include a finger tip.

21  
22 86. The apparatus defined in claim 83, wherein the skin-covered body part includes a  
23 nose tip.

24  
25 87. The apparatus defined in claim 83, wherein the skin-covered body part includes a  
26 palm of a hand.

27  
28 88. The apparatus defined in claim 83, wherein the skin-covered body part includes an  
29 ear.

30  
31 89. A method, including:

- 32 - releasing a prompting signal to prompt submission of a skin-covered body part  
33 at a biometric module;

- 1       - responsive to acquisition of an image further to releasing the prompting signal,  
2       producing a candidate code based on geometric measures of respective  
3       combinations of pixels taken from a plurality of subsets of like-shaded pixels  
4       in the image;
- 5       - releasing the candidate code via the communication interface for comparison  
6       at the management entity with an expected code, thereby to verify presence of  
7       a person associated with the expected code.

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9   90. An apparatus including:

- 10       - means for releasing a prompting signal to prompt submission of a skin-  
11       covered body part at a biometric module;
- 12       - means responsive to acquisition of an image further to releasing the prompting  
13       signal, for producing a candidate code based on geometric measures of  
14       respective combinations of pixels taken from a plurality of subsets of like-  
15       shaded pixels in the image;
- 16       - means for releasing the candidate code via the communication interface for  
17       comparison at the management entity with an expected code, thereby to verify  
18       presence of a person associated with the expected code.

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